The Template Method Pattern

Other Considerations

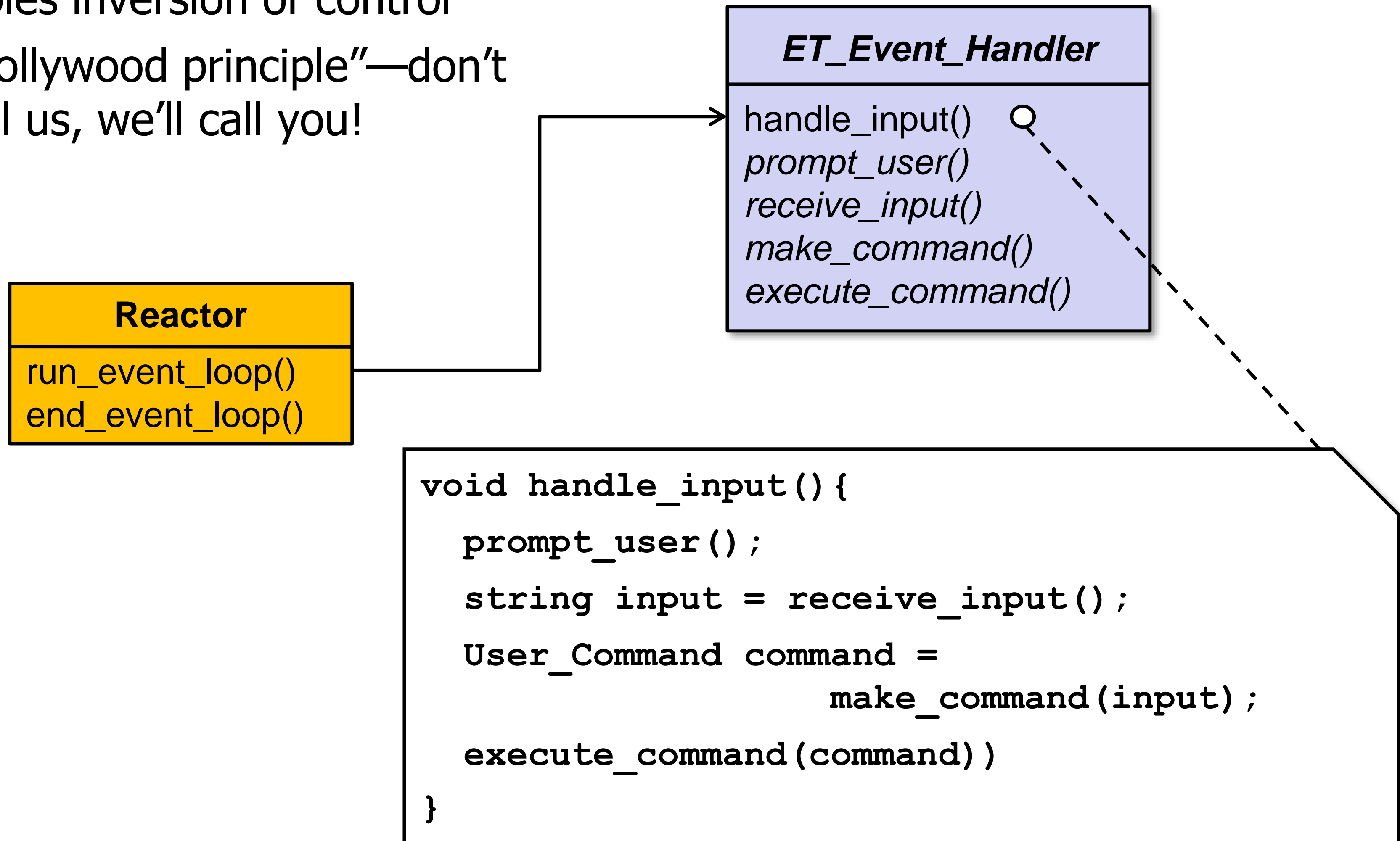
Douglas C. Schmidt

Learning Objectives in This Lesson

- Recognize how the *Template Method* pattern can be applied to flexibly support multiple operating modes in the expression tree processing app.
- Understand the structure & functionality of the *Template Method* pattern.
- Know how to implement the *Template Method* pattern in C++.
- Be aware of other considerations when applying the *Template Method* pattern.

Consequences

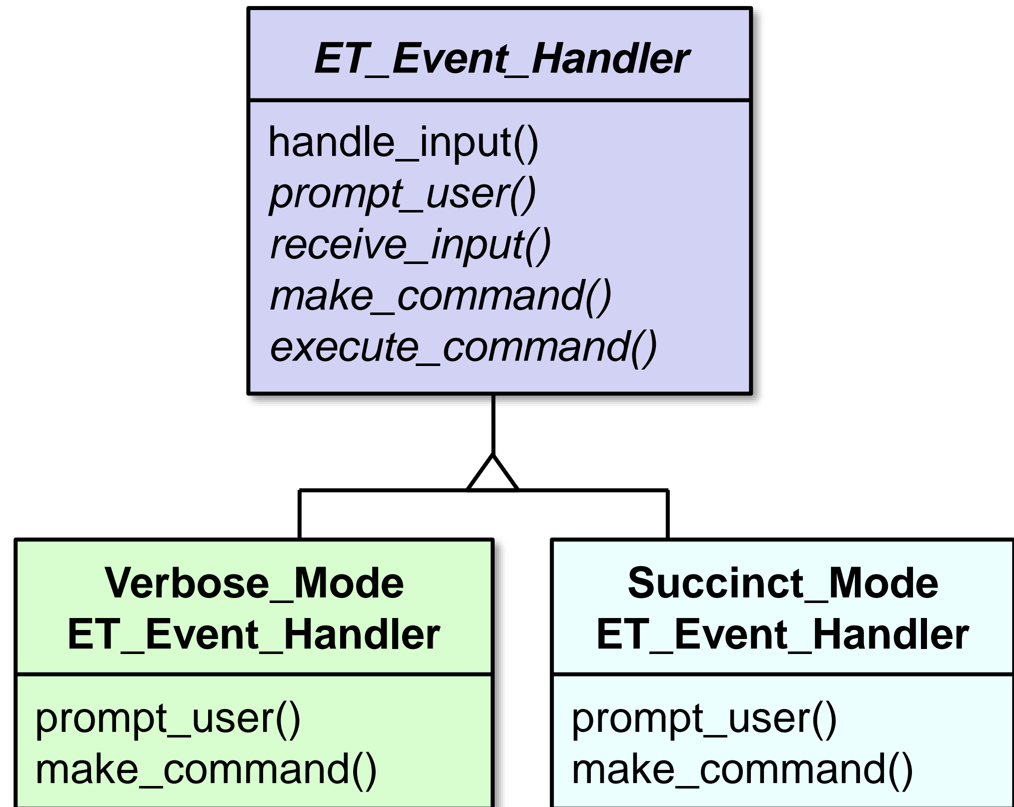
+ Enables inversion of control
  - "Hollywood principle"—don't call us, we'll call you!



See www.dre.vanderbilt.edu/~schmidt/Coursera/articles/hollywood-principle.txt

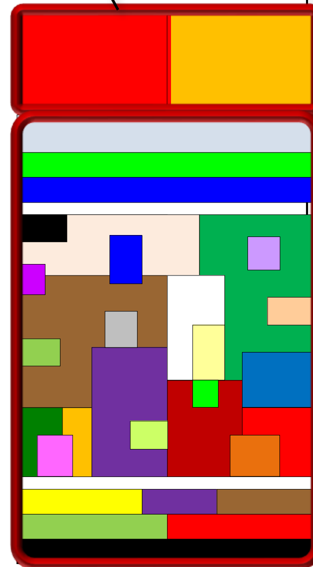
Consequences

+ Overriding rules are enforced via subclassing



Consequences

+ Promotes systematic reuse by collapsing stovepipes




```
expression_tree
"D:\Douglas Schmidt\Dropbox\Documents\Vandy\cs251\CPlusPlus\ex
1a. format [in-order]
1b. set [variable=value]
2. expr [expression]
3a. eval [post-order]
3b. print [in-order | pre-order | post-order | level-order]
0. quit
>format in-order

1. expr [expression]
2a. eval [post-order]
2b. print [in-order | pre-order | post-order | level-order]
0a. format [in-order]
0b. set [variable=value]
0c. quit

>expr -5 * (3 + 4)
```

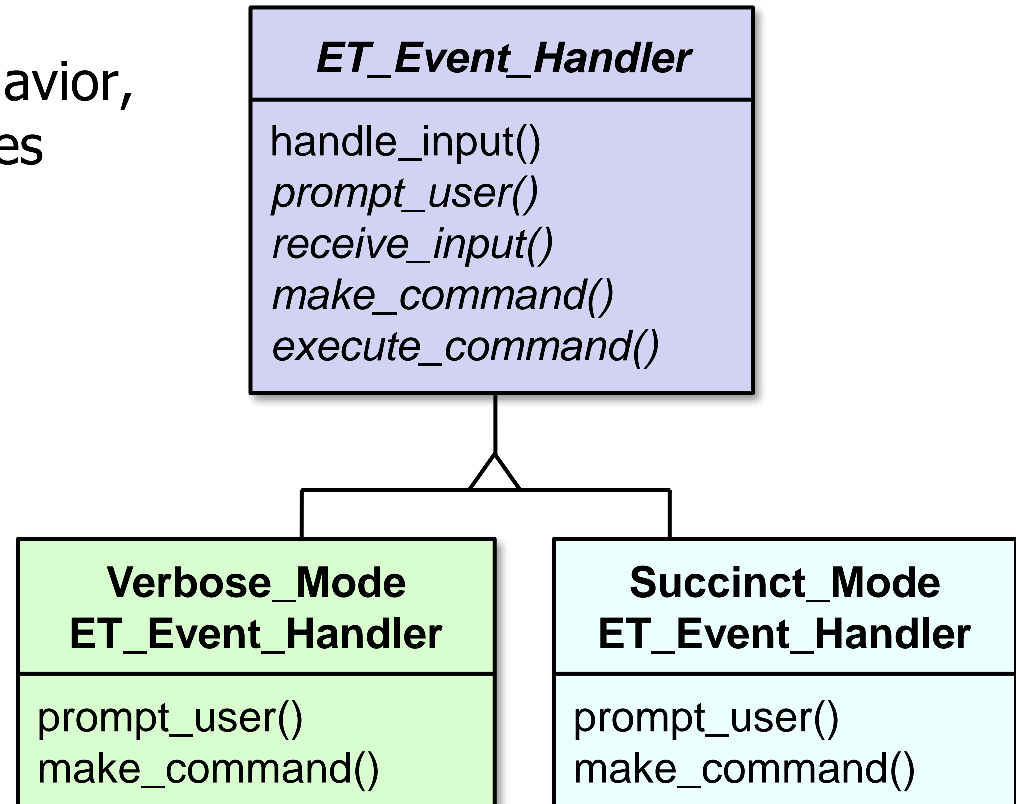
```
Run: expression_tree
"D:\Douglas Schmid
>-5 * (3 + 4)
 -35
4: Run  0: Messages  9: Git  Terminal  CMake
UTF-8  4 spaces  C++: expression_tree | Debug  master
```

www.dre.vanderbilt.edu/~schmidt/reuse-lessons.html has info on systematic reuse.

Consequences

– Must subclass to specialize behavior, which can yield many subclasses

- Compare & contrast with the *Strategy* pattern



Consequences

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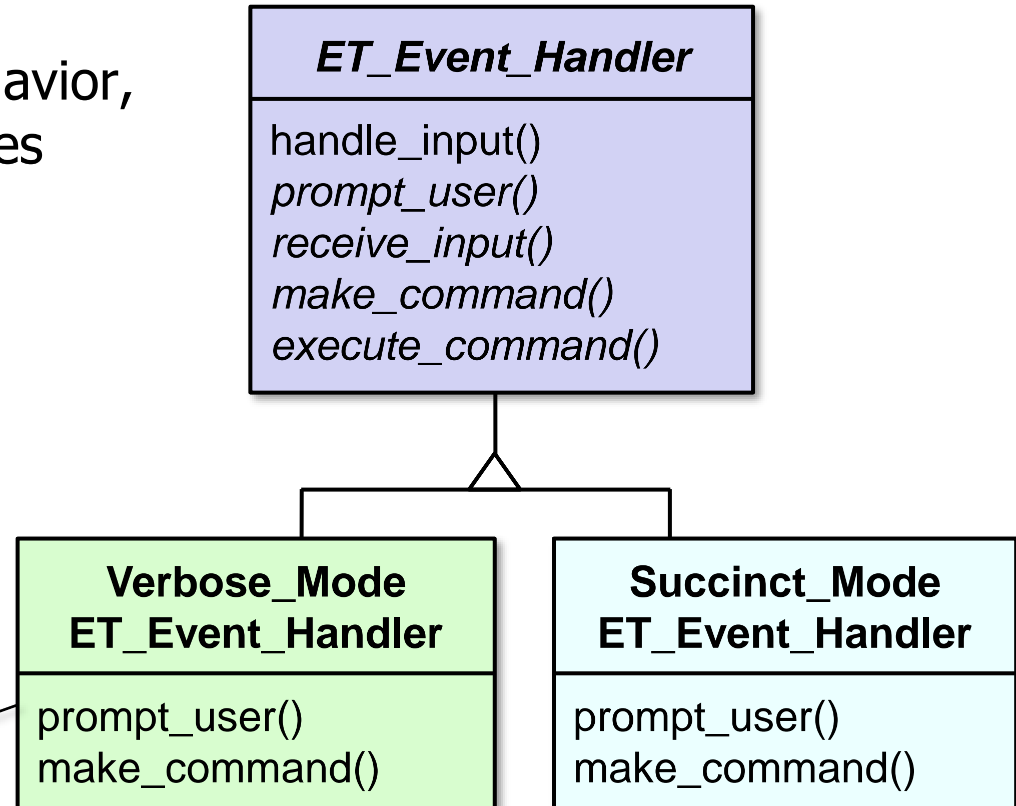
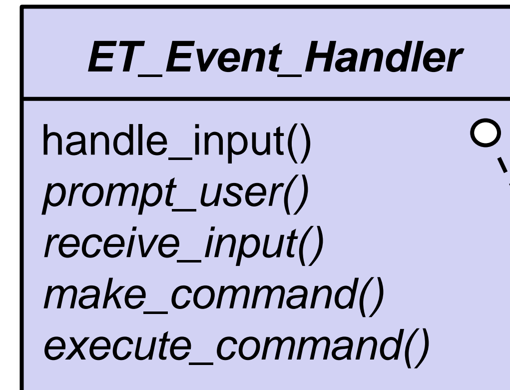


C++ lambda functions may help reduce the tedium of creating many subclasses.

Template Method GoF Class Behavioral

Implementation considerations

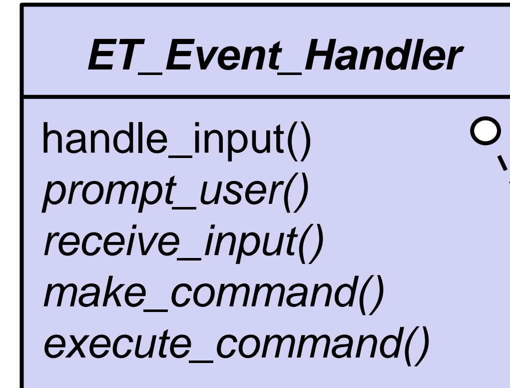
- Virtual vs. non-virtual (final) template method
  - Depends on whether the algorithm embodied by the template method itself may need to change




```
void handle_input() override {
  prompt_user();
  string input = receive_input();
  User_Command command =
                    make_command(input);
  execute_command(command))
}
```

Implementation considerations

- Few vs. many primitive operations (hook methods)
  - e.g., how much variability's needed in the template method's algorithm?

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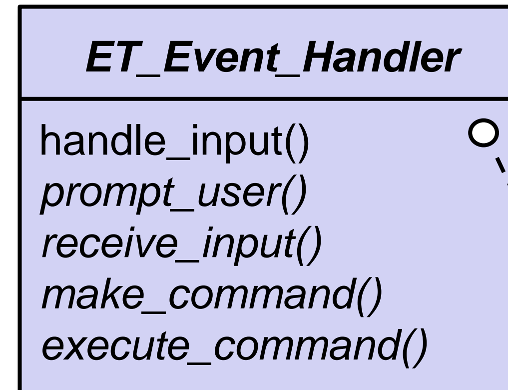
Implementation considerations

- Naming conventions
  - e.g., do*() vs. make*() vs. on*() prefixes

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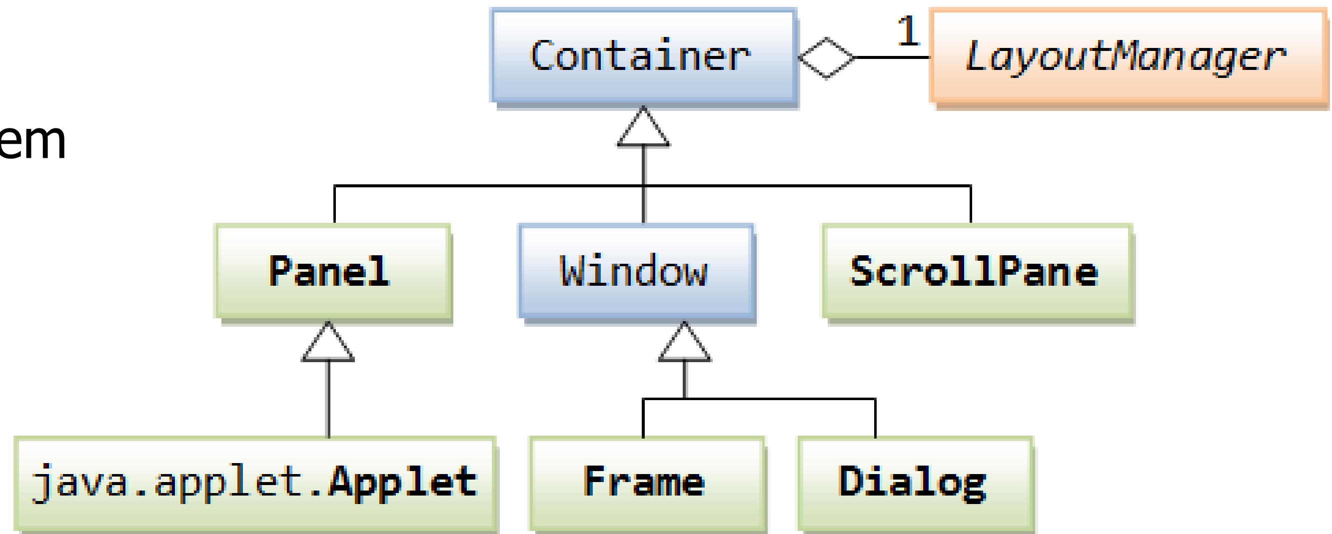
Known uses

- InterViews Kits
- ET++ WindowSystem
- AWT Toolkit



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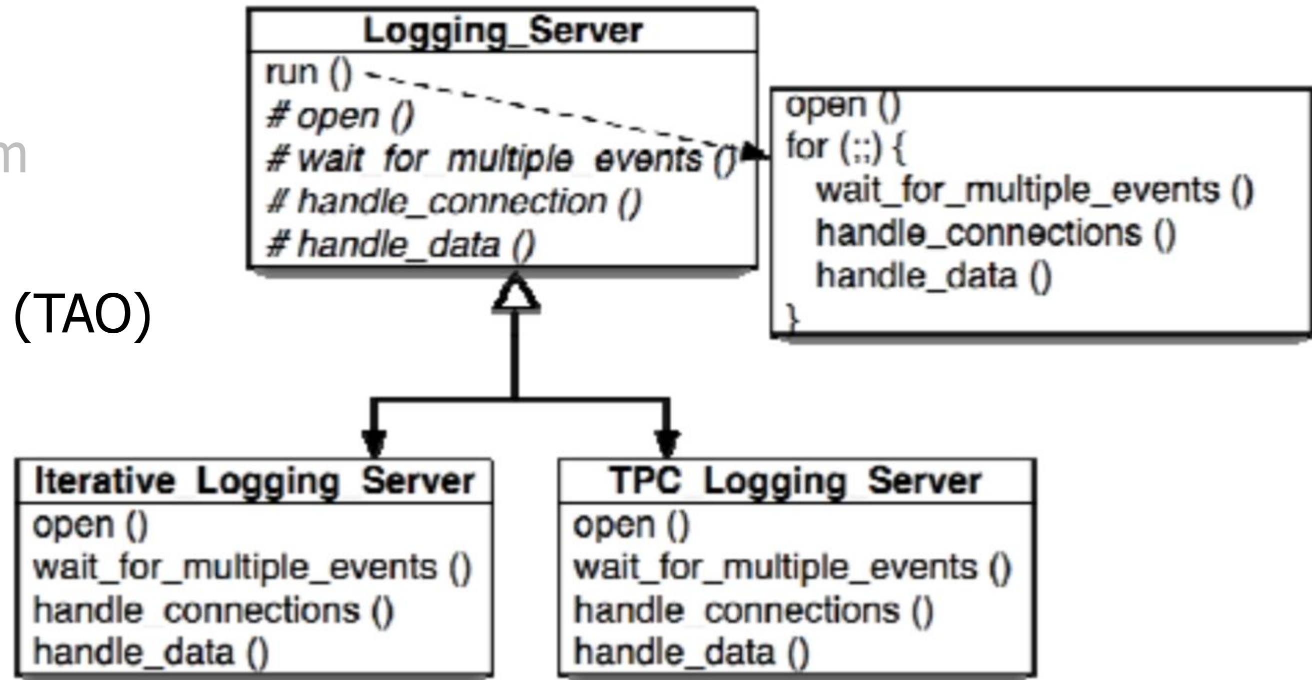
- ACE & The ACE ORB (TAO)



See www.dre.vanderbilt.edu/~schmidt/PDF/BC-schmidt.pdf

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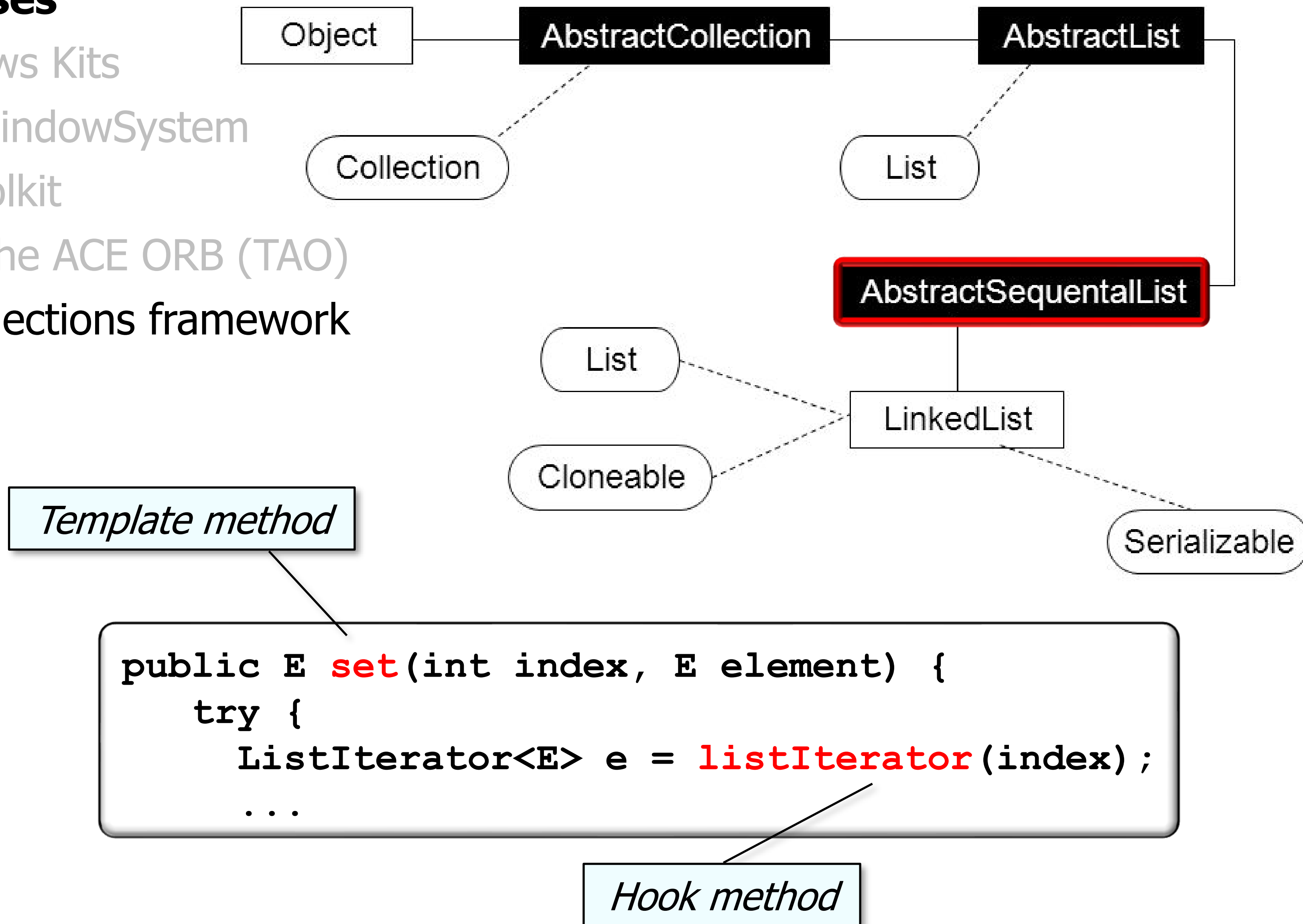

See refactoring.guru/design-patterns/template-method/java/example

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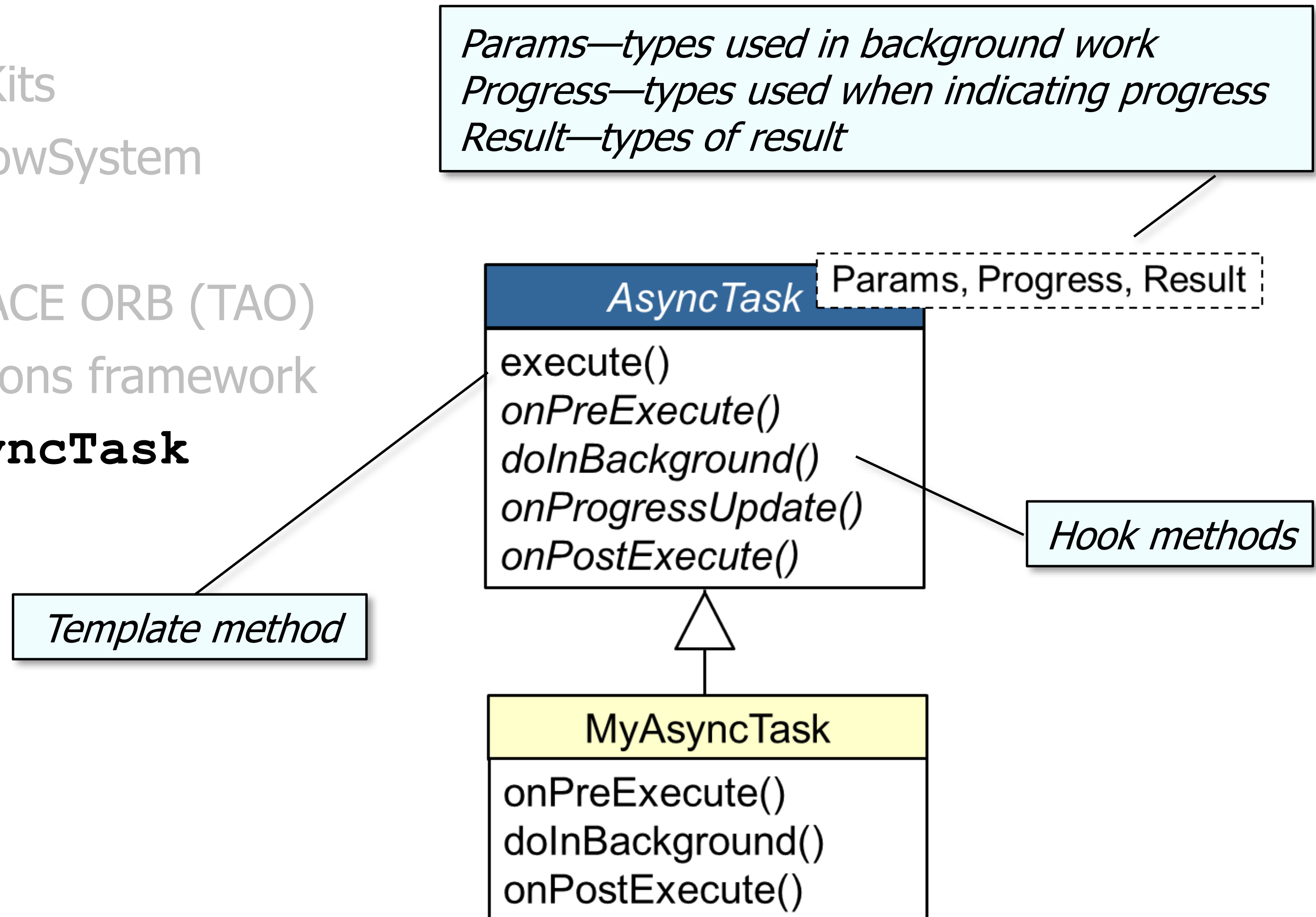
- Java Collections framework
- Android **`AsyncTask`** framework



See developer.android.com/reference/android/os/AsyncTask.html

Comparing Strategy With Template Method

Strategy

+ Provides for clean separation between components via “black-box” interfaces
+ Allows for strategy composition at runtime
+ Supports flexible mixing & matching of features
– May yield many strategy classes
– Incurs forwarding overhead

See www.dre.vanderbilt.edu/~schmidt/PDF/DRC.pdf

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Template Method

- + No explicit forwarding necessary
- + May be easier for small use cases due to "white-box" interfaces
- – Close coupling between subclass(es) & super class
- – Inheritance hierarchies are static & cannot be reconfigured at runtime
- – Adding features via inheritance may yield combinatorial subclass explosion
  - – Beware overusing inheritance since it's not always the best choice.
  - – Deep inheritance hierarchies in an app are a red flag.

We selected *Template Method* for our case study since it's a simple use case.

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Strategy &Template Method are often treated as "pattern complements" since they provide alternative solutions to related design problems.

See www.dre.vanderbilt.edu/~schmidt/POSA-tutorial.pdf

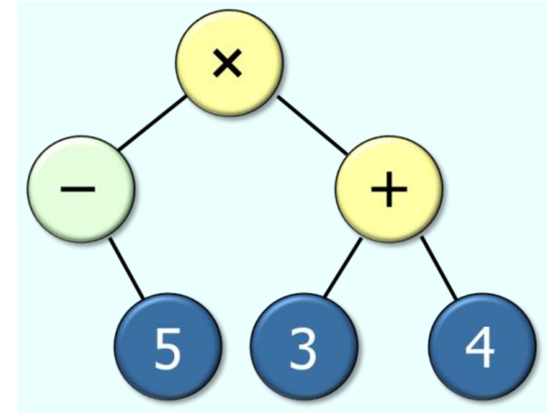
Summary of the Template Method Pattern

- *Template Method* enables controlled variability of steps in the **`ET_Event_Handler`** algorithm for processing multiple operating modes, which enhances reuse.

State

Tree_Context

format()
expr()
print()
evaluate()
...



Composite

Reactor

<<uses>>

Command

User_Command

ET_Event_Handler

<<creates>>

User_Command_Factory

Verbose_Mode ET_Event_Handler

Succinct_Mode ET_Event_Handler

Factory Method

Template Method